Editor's note: In this exclusive series, Michigan State University researchers tell growers how to give the public what they want: perennials in flower. Part Four provides precise prescriptions for coreopsis grandiflora. These 10 articles will be bound into a handy booklet at the end of the year.

by MEI YUAN, DR. ROYAL D. HEINS, DR. ARTHUR CAMERON, and DR. WILLIAM H. CARLSON

COREOPSIS GRANDIFLORA belongs to the Asteraceae plant family. The genus includes many annuals and perennials grown for their daisy-like, bright-yellow flowers. Coreopsis grandiflora is indigenous from Missouri and Kansas to Florida and New Mexico and is fully hardy from zones 4 to 9. The plant flowers from early summer to late fall and prefers full sun and fertile, well-drained soil. It grows as a rosette plant and bolts before flowering, often reaching a height of 2 feet. It makes a brilliant display in borders and gardens and is excellent as a cut flower. Coreopsis responds strongly to photoperiod, which allows growers to control and schedule flowering quite easily. It has great potential as a flowering potted plant and can be enjoyed in the home as well as in gardens. (Figure 1).

Cultivars
The most common cultivar is ‘Sunray,’ which has double gold-yellow flowers about 1-2 inches across. ‘Goldfink’ is a short-lived, dwarf plant that has 2-inch single yellow flowers with an orange center. ‘Sunburst’ has semidouble golden yellow flowers. ‘Early Sunrise’ is purported to be a cross between C. grandiflora and C. lanceolata. It is a short-lived cultivar and is unique in that it does not have a requirement for cold before flowering. Many other cultivars also exist.

Flower Induction Requirements
Flowering requirements vary among Coreopsis species and even cultivars. Unless stated otherwise, the
following suggested production information is based on ‘Sunray.’ It may not be appropriate for other cultivars and will not be appropriate for other Coreopsis species such as C. verticillata ‘Moonbeam’ or C. rosea. In order to flower, C. grandiflora ‘Sunray’ plants must be mature, must have received a cold treatment, and must be exposed to long days.

1. PLANT SIZE
After germination, seedlings are juvenile and will not flower in response to vernalization or photoperiod. ‘Sunray’ reaches maturity when plants develop about eight nodes (16 visible leaves). Until then, they should be grown under a photoperiod shorter than 13 hours to promote lateral branching. If only part of a population is mature, only part of the plants will flower (Figure 2). Mature plants will develop about eight new nodes (16 leaves) under the flowers from forcing to bloom.

2. COLD TREATMENT
A 10-week cold period at about 41°F (5°C) in a cold greenhouse or cooler is recommended for flower induction in ‘Sunray’ (Figure 3). Extending the cold treatment from 10 to 15 weeks will enhance flowering percentage on marginally mature plants, although the time to flower for flowering plants remains unchanged. ‘Early Sunrise’ does not have an obligate cold requirement to flower. It does require long days (LD) to flower. We have conflicting experiences about this cultivar’s requirement for a period of short days (SD) before exposure to LD. Because we are uncertain at this point, we recommend that ‘Early Sunrise’ plants be exposed to SD (days shorter than 12 hours) for at least 6 weeks before exposure to LD if precise timing to flower is required.

3. PHOTOPERIOD
Horticulturally, all C. grandiflora cultivars, including ‘Early Sunrise’ and ‘Sunray,’ are obligate LD plants. Fastest flowering occurs when plants are exposed to LD of 14 hours or more (Figure 4) or are provided night-interruption lighting for 4 hours from 10 p.m. to 2 a.m. (Figure 5). Plants should be exposed to at least 3 weeks of LD. After flowering is initiated, their development will continue even if the plants subsequently are placed under SD.

Incandescent, high-pressure sodium, cool-white fluorescent, and metal halide lamps all are effective for night interruption. However, incandescent light may cause more stem elongation than other light sources (Figure 6). The minimum intensity should be 10 footcandles.

4. PROPAGATION
Coreopsis can be propagated by seed or division. Division is used most commonly by the gardener for rejuvenation or control of plant size and is preferably done in the spring. Seed propagation is prevalent for commercial production because it is less expensive. Cold treatment of seed is beneficial but not required for germination. However, darkness is required, which necessitates that seeds be covered with medium or germinated in a dark chamber. Keep the medium at 68°-72°F (20°-22°C) and the humidity high (90%-95%). Seedlings will emerge in about a week.

5. MEDIA AND FERTILIZATION
Coreopsis does not have specific media requirements; plants will grow well in any well-drained evenly moist medium. The pH should be maintained from 5.8-6.4.

Coreopsis prefers low to moderate fertility; constant fertilization at 100-150 ppm N from a balanced fertilizer is adequate. Plants become very lush under high fertility.

6. LIGHTING AND SPACING
Coreopsis thrives in bright light. Supplemental lighting from high-pressure sodium lamps at 400-500 footcandles is beneficial.
candles hastens development and improves quality during winter.

7. IRRIGATION
Plants grow rapidly, develop a large leaf area, and require frequent irrigation. Plants readily wilt as the medium dries under high light conditions, which is especially a problem in small pots. Recovery, however, is rapid after watering without detrimental effects, as long as the water stress is not severe.

8. PLANT HEIGHT CONTROL
Coreopsis tends to be too tall when grown in 4- or 6-inch pots. Two methods can be used to control plant height: limited induction photoperiod (LIP) and growth retardants. With LIP, plants are given 3 weeks of LD, then grown to flower under a photoperiod shorter than 14 hours.

Returning plants to SD will delay flowering by up to several days and will reduce flower-bud number compared to continual LD but plants are shorter. However, once visible, buds develop at the same rate under LD or SD.

Growth regulators also can be used effectively to control plant height. Our research shows that B-Nine and Sumagic are the most effective (Figure 7). Both growth regulators reduce stem elongation under LD conditions but delay flowering in the process. We have observed almost 2 days' delay for every inch in height reduction compared to untreated control plants.

9. TEMPERATURES AND CROP SCHEDULING
Coreopsis grows and develops fast in warm temperatures. After germination, plants should be grown at 70°-75°F (21°-24°C) to shorten the juvenile phase. During forcing to flower, temperatures higher than 70°F (21°C) reduce flower-bud number, so 65° - 68°F (18°-20°C) is optimum for fast flowering with high quality.

Once LD begins, time to flower depends on the forcing temperature. Allow about 10-11 weeks at average daily temperatures of 59°F (15°C), 8-9 weeks at 64°F (18°C), or 7-8 weeks at 68°F (20°C) (Table 1 next page).

Plants can be purchased in different size plugs or as field-grown plants (Figures 8, 9, and 10 on next page). Final plant size will depend on the size of the plant at the start of LD. Like many other seed-propagated crops, coreopsis exhibits some variability in time to flower between plants in a population (Figures 11a

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**Figure 11A** Coreopsis 'Early Sunrise' Visible bud and flower dates

**Figure 11B** Coreopsis 'Early Sunrise'

Left: Distribution of plants reaching visible bud (VB) and flower of a 200-plant population we forced to bloom at 65°F (18°C).
Right: Distribution in time from VB to flower for 200 C. grandiflora 'Early Sunrise' plants growing at 65°F (18°C).

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Coreopsis grandiflora ‘Sunray’ Production Schedule

<table>
<thead>
<tr>
<th>Growing Time</th>
<th>Cultural Practice</th>
<th>Temperature</th>
<th>Photoperiod</th>
</tr>
</thead>
<tbody>
<tr>
<td>1-2 weeks</td>
<td>Sow seeds</td>
<td>65°-72°F (18°-22°C)</td>
<td>&lt;14 hours of light</td>
</tr>
<tr>
<td></td>
<td>OR purchase plugs</td>
<td></td>
<td></td>
</tr>
<tr>
<td>8-12 weeks</td>
<td>Grow until at least</td>
<td>72°-76°F (22°-24°C)</td>
<td>&lt;14 hours of light</td>
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<tr>
<td></td>
<td>16 leaves have formed</td>
<td></td>
<td></td>
</tr>
<tr>
<td>10-15 weeks</td>
<td>Cold treatment</td>
<td>35°-45°F (1°-7°C)</td>
<td>&lt;14 hours of light</td>
</tr>
<tr>
<td>(Can be held longer if needed)</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Begin Forcing

- 60°F (15°C)
- 6-7 weeks
- flower

Additional information:
- C. grandi- 

10. DISEASE AND INSECT PESTS

Coreopsis does not have many pests but is susceptible to powdery mildew and aphids. Plants are susceptible to tospoviruses such as impatiens necrotic spot virus (INSV), which is spread by thrips and causes black spotting on leaves and petioles.

11. POSTHARVEST CONCERNS

For longer shelf life, plants should be shipped when the first flower opens. Spent flower heads should be removed to keep plants vigorous and prolong blooming. Plants will continue flowering if provided bright light and sufficient water and can be enjoyed for many years as garden plantings.

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